United States Patent

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[54] WELDING HEAD WITH TOGGLE CLAMP

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[52] **U.S. Cl.** .....**219/60 A**, 219/159, 219/161

[51] **Int. Cl.**.....**B65d 43/24**

[58] **Field of Search**.....219/59, 60 A, 60 R, 61, 161, 219/125, 158, 159

[56] **References Cited**

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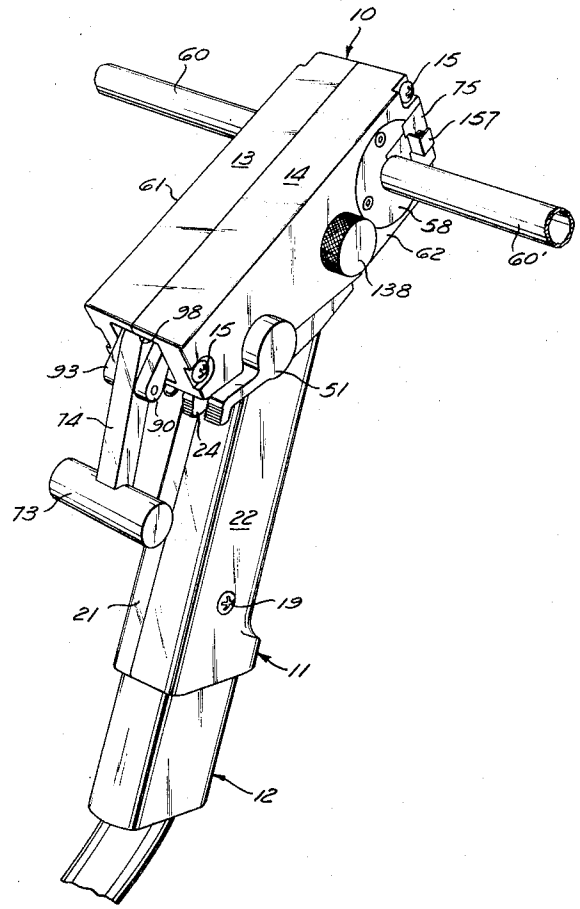
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[57] **ABSTRACT**

An in-place inert gas tube welder is disclosed which includes a head portion and a handle portion. The head portion includes a clamping means having an over center toggle for clamping the tubes to be welded. A sectored ring carries a nonconsumable tungsten electrode along a path adjacent the junction of of tubes to be welded. Inert gas is supplied to the welding chamber around the full 360° of the joint. A one-way clutch permits manual rotation of the sectored ring. The handle portion includes a drive motor for rotating the sectored ring, a means for supplying inert gas to the welding chamber, and a means for supplying electrical power to the electrode. An attachment means releasably secures the handle portion to the head portion. A supply cable is releasably connected to the handle portion for releasably connecting an inert gas source to the means for supplying inert gas to the welding chamber and for releasably connecting an electrical power source to the means for supplying electrical power to the electrode.

11 Claims, 9 Drawing Figures



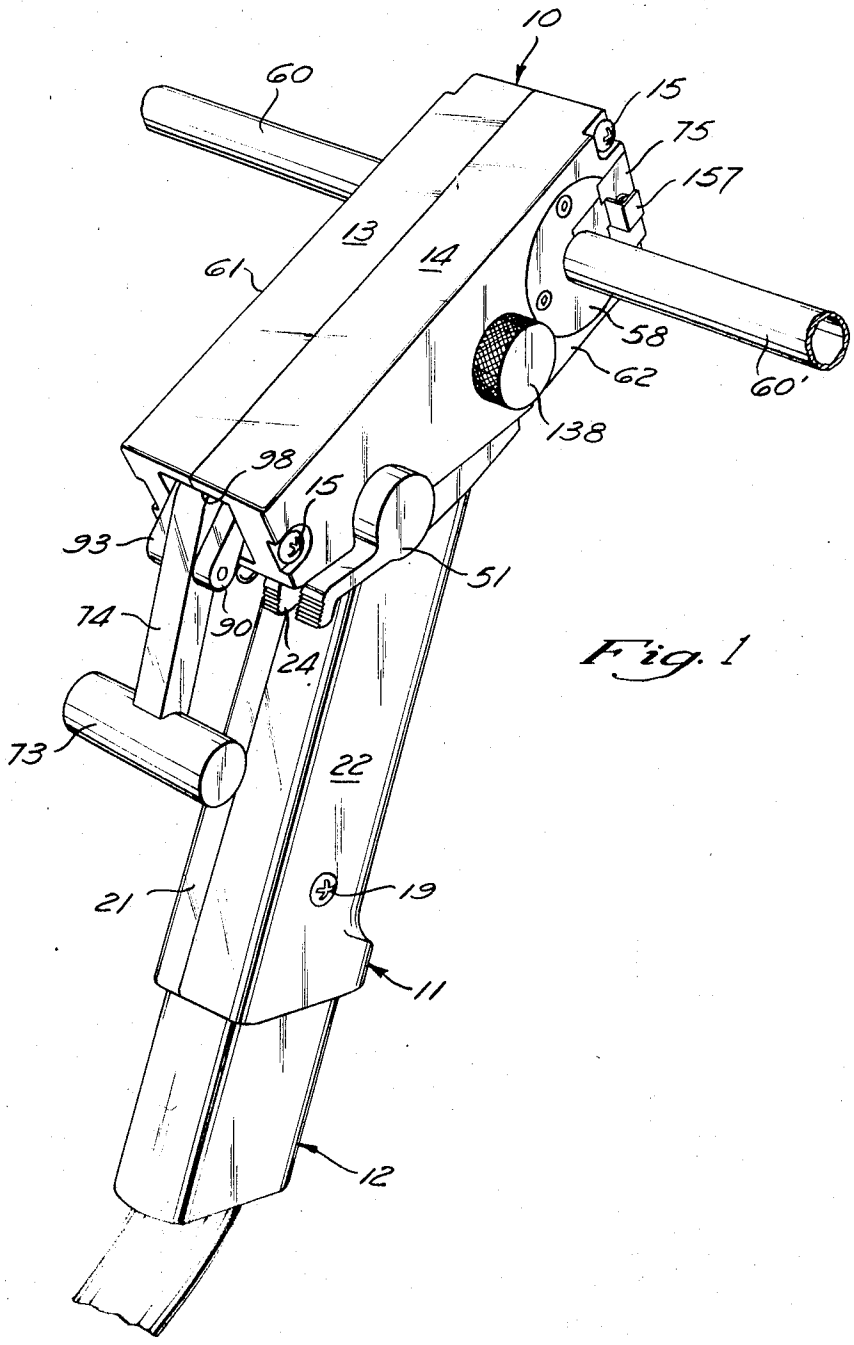


Fig. 1

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Fig. 2

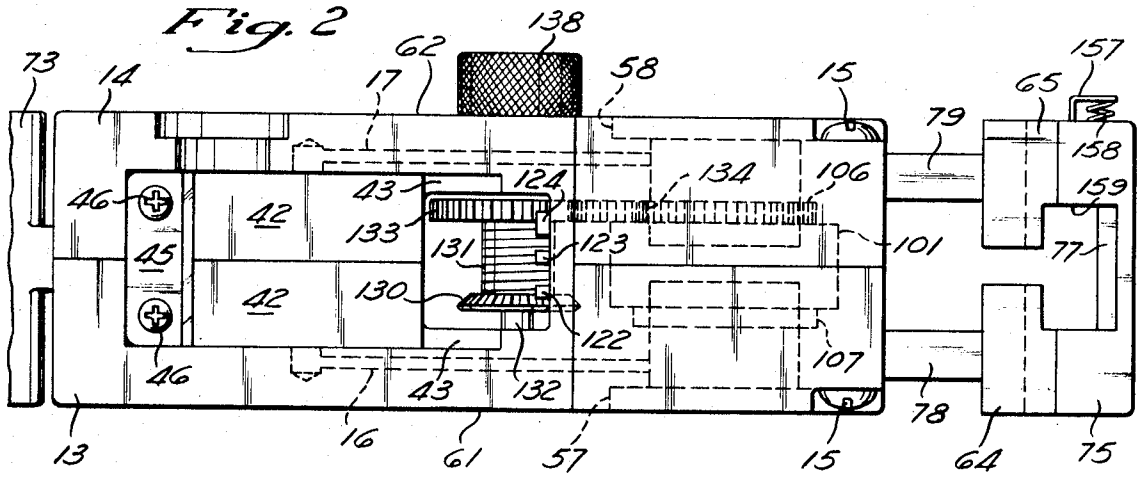
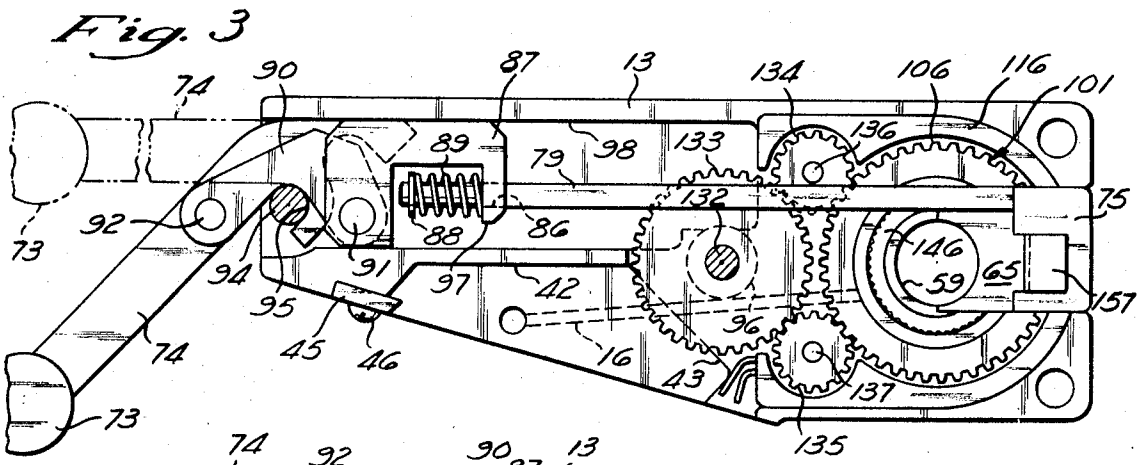


Fig. 3



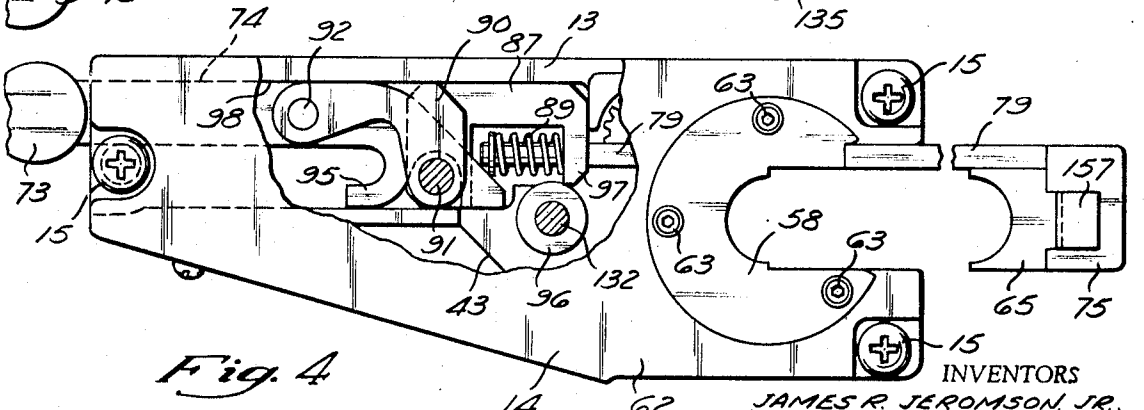


Fig. 4

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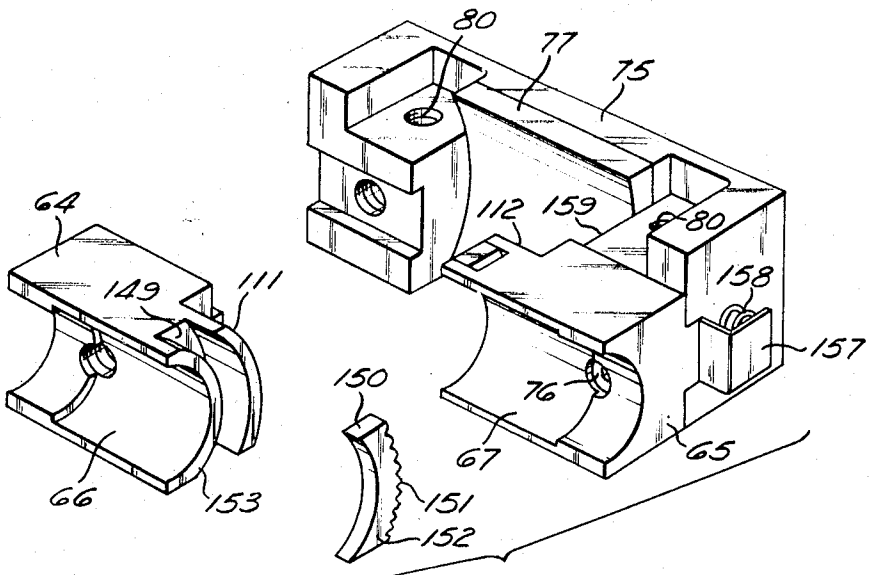


Fig. 5

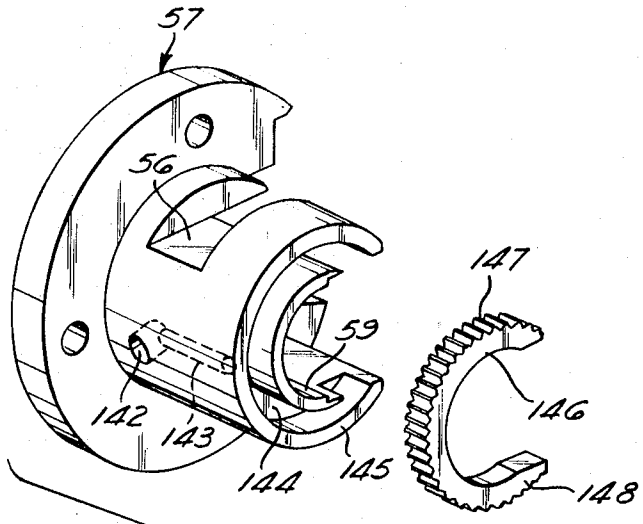


Fig. 6

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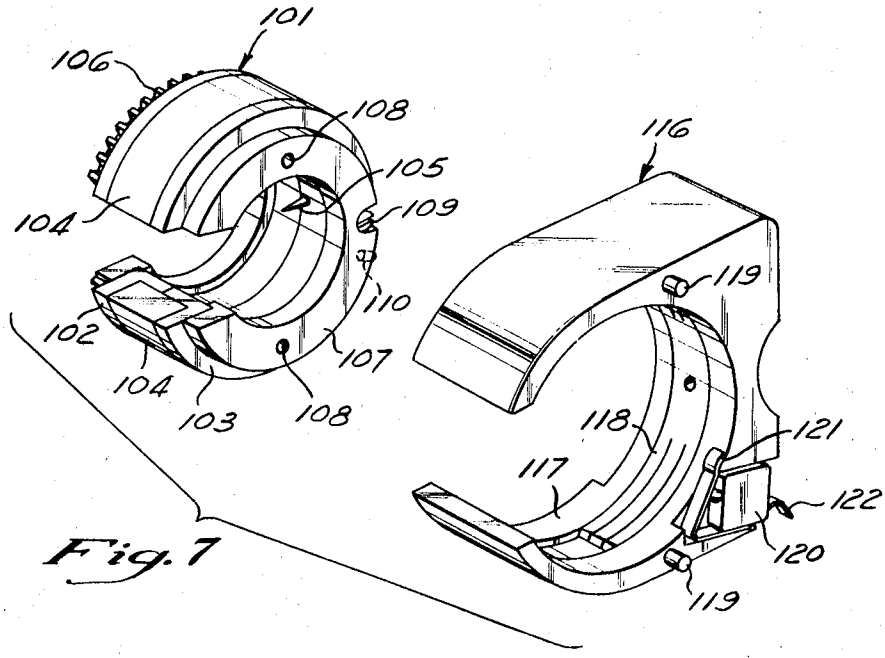


Fig. 7

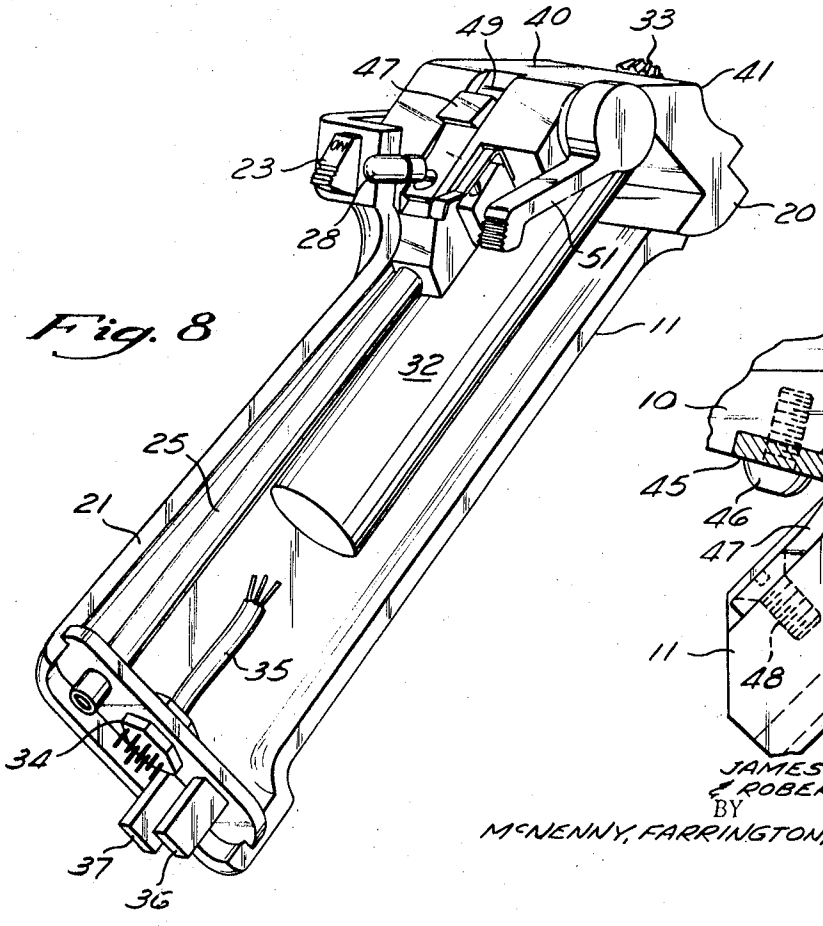
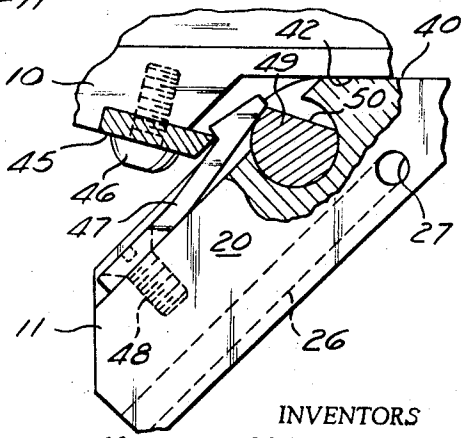


Fig. 8

Fig. 9



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WELDING HEAD WITH TOGGLE CLAMP

BACKGROUND OF THE INVENTION

This invention relates generally to welders, and more particularly to portable nonconsumable electrode inert gas welders for in-place welding of tubing and the like.

Portable inert gas welders of the type disclosed in U.S. Pat. No. 3,534,199 are widely used for in-place welding of tubing and the like. Such welders are particularly useful for in-place welding of tubing in aircraft assembly operations, since they require very little working space around the joint to be welded and further because the weld is performed in an inert atmosphere.

Such prior art welders generally include a nonconsumable electrode which is carried by a sectored carrier ring. The tubes that are to be welded are positioned in the welder and clamped in place. Inert gas is supplied to the welding chamber, and the carrier ring is rotated to move the electrode about a path adjacent the junction of the tubes to be welded. After the welding, the clamps are opened to permit removal of the welded joint.

The clamping means for such prior art welders generally includes a fixed clamp and a movable clamp. The clamping means must usually operate to move the movable clamp through a relatively large distance, because the movable clamp must move from a position adjacent the fixed clamp within the carrier ring to a position outside of the carrier ring a sufficient distance to prevent removal of the workpiece. Furthermore, since the welding operation may take several minutes the clamping means must provide a means to hold and lock the movable clamp in the closed position.

To meet these requirements, clamping means for such prior art welders have generally included a threaded rod extending from the movable clamp. A suitable screw thread means is provided to displace the threaded rod to move the movable clamp toward and away from the fixed clamp. Such prior art clamping means are time consuming to operate, since the screw thread means must be rotated to displace the movable clamp from its fully opened to its fully closed position. Furthermore, such prior art clamping means do not provide a means to insure that the correct clamping force will always be applied, particularly in view of the thermal expansion of the parts because of the heat produced during the welding operation.

SUMMARY OF THE INVENTION

These and other problems and disadvantages of prior art inert gas welders are overcome by the present invention, which provides a welder having a clamping means which includes a handle means and a link means for transmitting a force applied to the handle to a movable clamp and for multiplying the force applied to the handle solely when the movable clamp is in its closed position. In this manner, the movement of the handle means is minimized because the applied force is not multiplied until the movable clamp is in the closed position. After the movable clamp is in the closed position, however, the link means increases the applied force to insure an adequate clamping force. The invention further provides a lost motion and spring means for applying the increased force to the movable clamp. This insures that a predetermined clamping force will be applied regardless of minor variations in the size of the workpiece and it will compensate for the thermal expansion of the parts being welded.

In a preferred embodiment, the inert gas welder includes a body portion, an electrode, a carrying means for carrying the electrode along a path, and a clamping means for clamping a tubular workpiece adjacent the path. The clamping means includes a first clamping portion and a first attachment means securing the first clamping portion to the body portion. The clamping means further includes a second clamping portion and a second attachment means for securing the second clamping portion to the body portion and for moving the second clamping portion between an opened position away from the first clamping portion and a closed position adjacent the first clamping portion. The second attachment means includes a handle means and a link means. The handle means is movable along a first path for moving the second clamping portion between the open position and the closed position and is further movable along a second path to apply a clamping force to the second clamping portion. A link means transmits a force applied to the handle to the second clamping portion and through a toggle action multiplies the force applied to the handle when the second clamping portion is in the closed position to minimize the required movement of the handle and by reaching an overcenter position holds the parts in a locked position. The link means includes a spring means for applying the increased force to the second clamping portion so that the clamping force is applied regardless of minor variations in the size of the workpiece. Because the first path is substantially at right angles to the second path this minimizes the work space required to operate the welder.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects and advantages of the present invention will become readily apparent upon a full understanding of the preferred embodiment shown in the drawings, wherein:

FIG. 1 is a perspective view of an inert gas welder according to the present invention with a workpiece clamped therein;

FIG. 2 is a bottom view of the welding head shown in FIG. 1 with the handle portion removed and with the clamp shown in the open position;

FIG. 3 is a side elevational view of the welding head with one of its housing side portions removed for clarity and with the clamp shown in the closed position;

FIG. 4 is a side elevational view of the welding head with portions broken away to show the clamp linkage mechanism with the clamp in the open position;

FIG. 5 is an enlarged exploded perspective view of the movable clamp showing one segment of the inert gas supply means;

FIG. 6 is an enlarged exploded perspective view of the stationary clamp showing the other segment of the inert gas supply means;

FIG. 7 is an enlarged exploded perspective view of the electrode carrier and the carrier retainer;

FIG. 8 is an enlarged schematic perspective view of the handle portion with portions removed for clarity; and

FIG. 9 is an enlarged side elevational view of the attachment means for securing the handle portion to the body portion.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings in greater detail, FIG. 1 shows an inert gas welder having a welding head portion **10**, a handle portion **11**, and a supply cable **12**. The welding head portion **10** includes a housing or body portion having two sections **13** and **14**, which are secured together in alignment by suitable screws **15**. Each section is machined to provide suitable channels and surfaces for receiving and positioning other parts of the welder and for defining portions of the welding chamber as described in detail hereinafter. The sections **13** and **14** are provided with drilled gas passages **16** and **17**, respectively, for conveying inert gas supplied by the handle portion **11** to the welding chamber as explained in detail hereinafter.

FIGS. **1**, **8** and **9** show the handle portion **11**. The handle portion **11** includes a main support member **20** and mating housing portions **21** and **22**. The housing portions **21** and **22** are secured to the support member **20** and to one another by suitable screws **19**, and provide a grip for the operator. A start switch **23** and a stop switch **24** are provided to start and stop the welding cycle in the remote electrical welding control which controls the operation of the control input to the welder. A gas passage is provided to supply inert gas to the passages **16** and **17** of the welding head portion **10** when the

head portion and the handle portion **11** are connected. This gas passage includes a gas tube **25** which extends from the bottom of the handle portion **11** to the main support member **20**. The gas passage further includes a passage **26** drilled in the main support member **20** from the junction of the main support member **20** and the tube **25**. A transverse passage **27** is drilled laterally from side to side through the support member **20**. When the head portion **10** and the handle portion **11** are connected, the transverse passage **27** is aligned with the gas passages **16** and **17** of the head portion **10** to supply inert gas thereto.

A power unit **32** is also mounted on support member **20**. The power unit **32** includes a variable speed electric motor, a tachometer feedback unit for indicating the speed of the motor, and a gear reduction unit for increasing the torque and decreasing the speed of the electric motor output. A pinion gear **33** is secured to the output shaft of the gear reduction unit of unit **32** by a shear pin (not shown) to provide driving torque for the welder electrode as explained in detail hereinafter. An indicator light **28** is provided to indicate that the power supply unit **32** is actuated and that a welding cycle is in progress.

A multiple pin male connector socket **34** is provided on the bottom end of the handle portion **11**. The lead wires from the socket **34** are encased within a sheath **35**, and have been partially deleted from FIG. **8** for clarity. Two of the pins of connector socket **34** are utilized for supplying electrical power to the electric motor of unit **32**, and other pins are used for the tachometer feedback of unit **32**, start switch **23**, stop switch **24**, and indicator light **28**. Still other pins are electrically connected to an automatic positioning limit switch as will be described in detail hereinafter. Bus bars **36** and **37** are provided to supply electrical power to the electrode and to ground the welder.

The supply cable **12** is provided to releasably connect the control equipment to the welder so that the control equipment can be used with more than one welder. The supply cable **12** is provided with a plug which is received by the lower portion of the handle portion **11**, as may be understood with reference to FIG. **8**. The supply cable **12** includes a gas passage for supplying inert gas from a gas source to the gas supply tube **25** and an electrical connector for connecting an electrical power source to the bus bars **36** and **37** for supplying electrical power to the electrode. The supply cable **12** further includes an electrical connector for connecting each pin of connector socket **34** to the control equipment.

An attachment device is provided to releasably secure the head portion **10** and the handle portion **11** together. In this manner, welding heads of various sizes for accommodating tubing of various size ranges may be provided without having to provide a complete welder for each such size range. Furthermore, this permits the tubing that is to be welded to be clamped in the head portion **10** without requiring the control equipment and handle portion to remain idle.

As best seen in FIGS. **3**, **8** and **9**, the attachment device includes alignment surfaces for properly aligning the welding head portion **10** and the handle portion **11**, and a latch. The alignment surfaces include a first alignment surface **40** and a second alignment surface **41** on the support member **20** of handle portion **11**. Third and fourth alignment surfaces **42** and **43** are provided on the head portion **10** for engaging surfaces **40** and **41**, respectively, to align the head and handle portions of the welder. The alignment surfaces **40** and **41** of the handle portion and the alignment surfaces **42** and **43** of the head portion are angularly related to one another to provide positive positioning of the head portion and handle portion.

The latch includes a generally flat latching plate **45** secured to the housing sections **13** and **14** of the welding head **10** by screws **46**. A spring latch **47** is secured to handle portion **11** by screw **48**. A latch shaft **49** extends laterally through a suitable passage formed in the support member **20** of handle portion **11**. The shaft **49** is provided with a flattened portion **50** adjacent the spring latch **47**. A latch handle **51** is suitably secured to the shaft **49** so that rotational movement of the handle **51** rotates shaft **49** to move spring latch **47** between its outward position of engagement with latching plate **45** and a retracted position in which it is disengaged from plate **45** to permit separation of the handle portion **11** from the head portion **10**. The latching plate **45** and the spring latch **47** are permanently affixed to the head portion **10** and handle portion **11**, respectively, so that there are no loose parts to be handled when the head and handle portions are separated.

The workpiece clamp for securing workpieces in the welder may be best understood with reference to FIGS. **1–6**. The clamp includes a stationary clamping portion, a first attachment device for releasably attaching the stationary clamping portion to the body portion, a movable clamping portion, and a second attachment device for securing the movable clamping portion to the body portion and for moving the movable clamping portion between an open position and a closed position.

The stationary clamping portion includes a left clamping member **57** and a right clamping member **58**. The structural details of the clamping members **57** and **58** are similar, and the left clamping member is shown in detail in FIG. **6**. The left clamping member **57** includes a stationary clamping surface **59** for engaging a tube **60** as shown in FIG. **1**. The clamping members **57** and **58** are each provided with a suitable notch **56** for guiding the second attachment device as explained below. The left and right clamping members are received by suitable openings in the lateral side portions **61** and **62** of housing sections **13** and **14**, respectively. The first attachment device includes screws **63** which extend through a flange portion of each clamping member **57** and **58**, and which are threadably received by suitable threaded holes in the housing sections **13** and **14**. In this manner, the stationary clamping members **57** and **58** may be easily removed so that replacement clamping members having clamping surfaces for accommodating a different size tubing may be inserted. Because of the relatively large mass of the clamping members **57** and **58**, and since clamping members **57** and **58** contact housing sections **13** and **14**, respectively, over a relatively large surface area, heat flows from the workpiece or tubes **60** and **60'** to the clamping members **57** and **58** for cooling the tubes while they are being welded.

The movable clamping portion includes a left clamping member **64** and a right clamping member **65**. Clamping members **64** and **65** are provided with clamping surfaces **66** and **67**, respectively. In the preferred embodiment, each clamping surface is a stepped surface so that the portion having the smaller radius of curvature engages the respective one of tubes **60** and **60'** while the portion having the larger radius of curvature engages a sleeve (not shown) which is positioned over the joint that is to be welded.

The second attachment means includes a handle and a connecting linkage. The handle includes a hand receiving portion **73** and a link portion **74**. The handle is movable along a straight line path between the position shown in FIG. **4** and the position shown in phantom in FIG. **3** to move the movable clamping portion between an opened position away from the stationary clamping portion and a closed position adjacent the stationary clamping portion. The handle is further movable along a second path between the position shown in phantom in FIG. **3** in which the workpiece clamp is closed and the position shown by solid lines in FIG. **3** to apply a clamping force. The second path is an arcuate path, as will be explained in detail hereinafter, and is angularly related to the first path at an angle of substantially 90° to minimize the working space required to move the handle to secure a workpiece in the welder.

The connecting linkage includes a movable clamp carrier member **75** to which the movable clamping members **64** and **65** are secured by suitable screws **76**. A nylon insulator member **77** is cemented to the carrier **75** to minimize heat transfer through carrier **75** from the welding chamber. A left link rod **78** and a right link rod **79** are attached to carrier **75** by

suitable screws which are received by threaded holes **80** of carrier **75**. The link rods **78** and **79** are received and guided by the notches **56** in the stationary clamping members **57** and **58**, respectively.

The link rods **78** and **79** are each secured to the handle by a similar linkage. The linkage securing the right link rod **79** to the handle is best seen in FIGS. **3** and **4**. The left end of link rod **79** is slidably received within a bore **86** of a drag link **87**. A generally flat washer member **88** is secured on the left end of link rod **79**, such as by staking, and a coil spring **89** acts between the washer **88** and the drag link **87**. The drag link **87** is a generally flat member, and a generally flat toggle link **90** is disposed between the drag link **87** and link portion **74** of the handle. A first connecting pin **91** pivotally connects toggle link **90** to drag link **87**, and pivotally connects a similar drag link (not shown) to a similar toggle link **93** (FIG. **1**) of the linkage connecting left link rod **78** to the handle means. A second connecting pin **92** pivotally connects the toggle link **90** to the link portion **74**, and pivotally connects the toggle link **93** to the link portion **74**. The drag link and toggle link **93** for the left link rod **78**, which are not shown in FIGS. **3** and **4** but which are substantially similar to drag link **87** and toggle link **90**, as well as about one-half of link portion **74**, are slidably disposed in a cutout passage **98** of the left housing section **13**. In a similar manner, the drag link **87** and toggle link **90** are slidably disposed in a cutout passage (not shown) of the right housing section **14**. A pivot pin **94** extends laterally between housing sections **13** and **14**. A hook portion **95** is provided on link portion **74** for engaging pivot pin **94** when the movable clamping portion is in its closed position.

When the workpieces have been positioned within the opened clamp as shown in FIG. **2**, the handle is moved along the first path from the position shown in FIG. **2** to the position shown in phantom in FIG. **3**. This brings the clamping surfaces of the movable clamping portion to a closed position adjacent the clamping surfaces of the stationary clamping portion to encapsulate the workpieces on each side of the joint that is to be welded. With the handle in this position, the hook portion **95** engages pivot pin **94**. The handle is then moved from the position shown in phantom in FIG. **3** along a second path to the position shown by solid lines in FIG. **3**. When this occurs, the handle and hook portion **95** pivot about the pivot pin **94** and the force applied to the handle is transmitted to toggle link **90** by connecting pin **92** and to drag link **87** by connecting link **91**. Because the right link rod **79** is slidably disposed in bore **86**, the force is then transmitted through spring **89** to washer **88** and link rod **79**. In this manner, the coil spring **89** applies the clamping force to the workpiece so that a substantially constant clamping force is applied regardless of minor variations in diameter of the workpiece.

As the movable clamp is moved from its opened position to its closed position and the handle is moved along the first path, the manual force applied to the handle is transmitted directly to the movable clamp. However, this force applied to the handle is multiplied to apply a substantially greater clamping force when the movable clamp is in its closed position because of the toggle action produced when the handle is moved along the second path. As a result, the greater movement of the handle required by the mechanical advantage yielded by the connecting linkage occurs only when the movable clamping portion is in its closed position to minimize the working space required to actuate the handle. Also, the linkage is arranged such that the distance between the pivot pin **94** and the hand receiving portion **73** is greater than the distance between the pivot pin **94** and the connecting pin **92** to produce a mechanical advantage greater than that produced by the toggle action of link portion **74** and toggle link **90**.

When the handle is in the closed position shown in FIG. **3**, the connecting linkage also locks the movable clamps **64** and **65** in the closed position. To accomplish this, the connecting pin **92** is arranged such that it moves from a position vertically above the center of the pivot pin **94** to an overcenter position vertically below the center of pivot pin **94** when the handle is moved along its second path. Since the force applied to the connecting pin **92** by the toggle links **90** and **93** is exerted in a horizontal direction as viewed in FIG. **3**, the clamping force can pull the handle to the right only when the connecting pin **92** is vertically above the pivot pin **94**. Because of this, the travel of the connecting pin **92** over the center of the pivot pin **94** locks the movable clamps **64** and **65** in the closed position.

A bushing **96**, which provides a bearing for a drive shaft as will be explained in detail hereinafter, projects slightly into the cutout passage **98** as seen in FIGS. **3** and **4**. When the movable clamping portion is in its opened position as shown in FIGS. **2** and **4**, an end portion **97** of drag link **87** compresses and passes over the projecting portion of bushing **96**. In this manner, a detent is provided to hold the movable clamping portion in its opened position without interferring with the operation of the handle or linkage during any other portion of their operation.

The preferred embodiment further includes an electrode carrier **101**, the structural details of which are best seen in FIGS. **2**, **3** and **7**. The electrode carrier **101** includes two sections **102** and **103** formed of a strong, high temperature resistant insulating material such as boron nitride or other refractory material. An electrode shoe **104** of conducting material such as beryllium copper is disposed about the outside periphery of the carrier sections **102** and **103**. A nonconsumable electrode **105** of tungsten or the like is electrically connected to the shoe **104** and projects radially inwardly through the ceramic sections **102** and **103**. A carrier gear **106** is disposed on the side of carrier section **102**, and a spacer member **107** is disposed on the side of carrier section **103**. Connector pins **108**, preferably of filled nylon or teflon, extend laterally through carrier sections **102** and **103**, carrier gear **106** and spacer **107** and are held in place by suitable cement or adhesive to retain the various component parts of the electrode carrier in their proper positions. An adjustment screw **109** is threadably received by a lateral hole in the electrode shoe **104**. The screw **109** secures the electrode in place and may be loosened to permit removal or adjustment of the electrode **105**. An actuating pin **110** projects from the exposed lateral side portion of section **103** to actuate a sensing device when the electrode is in a predetermined position, as will be explained in detail hereinafter.

The electrode carrier **101** is rotatably journaled within a carrier retainer **116**. The carrier retainer **116** is of nylon in the preferred embodiment, and includes an opening **117** for receiving the carrier **101**. A flexible brush **118** is provided to supply electrical power to the electrode shoe **104** and electrode **105**. Locating pins **119** project into suitable holes (not shown) of housing section **13** to properly locate and position the carrier retainer **116**. A limit switch **120** is disposed on retainer **116** and is provided with a resilient actuating arm **121**. The actuating arm **121** is arranged in interferring relation with actuating pin **110**, so that the limit switch **120** is actuated by pin **110** when the electrode carrier **101** is in the position shown in the drawings. A first switch bus bar **122** is arranged on the carrier retainer **116** to engage a suitable electrical connector (not shown) on main support member **20** when the head and handle portions are joined together. The first electrical connector is electrically connected to one of the pins of socket **34**. A second bus bar **123** (see FIG. **2**) is arranged on carrier retainer **116** to engage a second electrical contact (not shown) on support member **20**. The second electrical contact is electrically connected to another of the pins of socket **34**. A third bus bar **124** is arranged on the carrier retainer **116** to engage a third electrical contact (not shown) on support member **20**. The third electrical contact is also connected to one of the pins of socket **34**. The first bus bar **122** and second bus bar **123** are electrically connected to the two terminals of limit switch **120**. The third bus bar **124** is electrically connected to the brush **118** to supply electrical power to electrode **105**.

As may be best seen in FIG. **2**, the stationary clamping members **57** and **58** and the movable clamping members **64**

and 65 extend through the annular carrier gear 106 and the annular spacer member 107, respectively. In this manner, the cylindrical exterior surface of the stationary clamping members 57 and 58 cooperates with the cylindrical exterior surfaces 111 and 112, respectively, of the movable clamping members to provide a continuous cylindrical journal for the electrode carrier 101 as it rotates.

The drive train for driving the electrode carrier 101 is best seen in FIGS. 2, 3, 7 and 8. As explained above, pinion 33 is connected to the drive shaft of motor unit 32 by a shear pin. When handle portion 11 is connected to the welding head 10, pinion 33 engages a bevel gear 130 which is rotatably mounted on a drive shaft 132. A helical clutch spring 131 is secured to bevel gear 130 and is coiled about the drive shaft 132. One end of the drive shaft 132 is rotatably journaled in bushing 96 of housing section 13, and the other end of the drive shaft 132 is rotatably journaled in a similar bearing (not shown) in housing section 14. A spur gear 133 is suitably connected to drive shaft 132 for rotational movement therewith. The free end of clutch spring 131 is adjacent spur gear 133 but is not connected thereto. Idler gears 134 and 135 are rotatably journaled on shafts 136 and 137, respectively, which are disposed on the carrier retainer 116. Each idler gear 134 and 135 engages both spur gear 133 and carrier gear 106 to transmit driving torque therebetween and to preclude interruption of torque transmission from gear 133 to carrier gear 106 when the opened portion of the sectored carrier gear 106 is adjacent one of the idler gears 134 or 135. One end of the drive shaft 132 projects through right housing section 14, and a knurled knob 138 is suitably secured thereto.

When motor unit 32 is supplied with electrical power, it provides driving torque for pinion 33 and bevel gear 130. As bevel gear 130 is rotated, it begins to rotate spring 131 in a direction to wrap the spring 131 more tightly on shaft 132 to rotate the shaft 132 therewith. This transmits the drive torque to the spur gear 133. Idler gears 134 and 135 transmit the drive torque from spur gear 133 to carrier gear 106 to rotate electrode carrier 101. This moves the electrode 105 along a circular path adjacent the junction of the workpieces that are to be welded.

If for any reason the electrode carrier is stopped in a position other than the open position shown in the drawings wherein the movable clamp may be opened to permit insertion of a workpiece, it may be desired to manually rotate the carrier 101 back to its opened position. However, the gear reduction unit of the power unit 32 precludes manual rotation of the drive motor through pinion 33. As best seen in FIG. 2, when the knurled knob 138 is rotated in a direction such that any friction between shaft 132 and coil spring 131 tends to unwind the spring, the spring 131 effectively disconnects the bevel gear 130 and motor unit 32 from shaft 132 to permit rotating torque to be applied to carrier gear 106 through spur gear 133. This provides a clutch to permit such manual rotation of the electrode carrier 101 without requiring a neutral position in the drive train gear unit.

As explained above, the supply cable 12 includes a gas passage to interconnect an inert gas source with tube 25 of the handle portion 11. The gas is then conveyed through tube 25 to passages 26 and 27 of support member 20. From passage 27, the inert gas is then conveyed to passages 16 and 17 in housing sections 13 and 14, respectively. The structure for conveying the inert gas from passages 16 and 17 to the welding chamber is best seen in FIGS. 2, 5 and 6. The left stationary clamping member 57 is provided with a passage 142 which extends radially inwardly from its outer periphery to intersect a transverse passage 143. The transverse passage 143 extends to an annular groove 144 in the radial side wall 145 of the clamping member 57. An annular distributing member segment 146 having a notched external periphery 147 is received by annular groove segment 144 so that its radial side wall 148 is aligned with radial side wall 145. The thickness of distributing member segment 146 is less than the depth of groove 144 so that a segment of an annular manifold is defined between the bottom portion of groove 144 and a sidewall portion of distributing member 146. In a similar manner, an annular groove segment 149 is provided in left movable clamping member 64 for receiving an annular distributing member segment 150. The segment 150 includes a notched external periphery 151. The thickness of the distributing member segment 150 is less than the depth of annular groove 149, so that a segment of an annular manifold is defined between the distributor segment 150 and the bottom of the annular groove 149 when the radial sidewall 152 of segment 150 is aligned with the radial sidewall 153 of left clamping member 64.

When the movable clamping portion is in the closed position, the above described manifold segment of stationary clamping member 57 will be aligned with the above described manifold segment of clamping member 64. This permits the inert gas to be supplied to the welding chamber through the notched portions of the distributor segments 146 and 150. An identical inert gas supply structure is provided in right clamping members 58 and 65. By introducing the inert gas into the welding chamber through sidewall portions of the workpiece clamp, the inert gas is introduced immediately adjacent the path of the electrode to remove hot gases and contaminates from the inlet location adjacent the electrode path. Furthermore, this provides a structure for introducing the inert gas along the entire electrode path at both sides of the electrode to insure a uniform welding atmosphere and a uniform gas cooling of the weld.

As best seen in FIGS. 2 and 5, an indicator tab 157 is slidably received between the right clamping member 65 and the clamp carrier member 75. A coil spring 158 biases the indicator tab 157 to its outward position shown in the drawings. The portion of the indicator tab 157 which is received between the clamping member 65 and the clamp carrier member 75 extends to the inner surface 159 of the clamp carrier 75. When the movable clamping portion is closed and it is desired to determine if the electrode carrier 101 is in the opened position shown in the drawings, the indicator tab 157 is manually pressed inwardly. If the electrode carrier is in the position shown in the drawings, the portion of the indicator tab 157 adjacent the inner surface 159 will project into the removed portion of the sectored carrier 101 to permit the indicator tab 157 to be pressed inwardly. However, if the carrier 101 is not in this position, the portion of the indicator tab adjacent the inner surface 159 will contact the carrier 101 and preclude such inward movement of the tab 157.

To operate the inert gas welder shown in the drawings, the welding head 10 may be separated from the handle portion 11 at the completion of a prior weld so that the handle portion 11 may be used with another welding head while a workpiece is being clamped in the welding head 10. With the welding head so separated, tubes 60 and 60' are inserted in the opened clamping means shown in FIGS. 2 and 4. If desired, a sleeve may be placed about the joint that is to be welded in a well-known manner. The handle is moved along its first path from the position shown in FIGS. 2 and 4 to the position shown in phantom in FIG. 3 to close the movable clamps 64 and 65. The handle is then moved along its second path from the position shown in phantom in FIG. 3 to the position shown by solid lines in FIG. 3. This applies a predetermined clamping force to the workpieces and locks the movable clamps 64 and 65 in the closed position. An inert gas supply is connected to the free end of the tube 60, and a restricted orifice is connected to the free end of tube 60' to provide an inert atmosphere inside of the tube.

The handle portion 11 and supply cable 12 are then connected to the welding head 10 to connect the control equipment (not shown) to the welding head 10. The control equipment, in a well-known manner, includes an inert gas supply, an electrode power supply, and a motor power supply. Prior to the commencement of a welding cycle, the inert gas supply control purges the welding chamber with an inert gas such as argon and then supplies a steady flow of inert gas to the welding chamber throughout the weld. The gas escapes through

various clearances of the welding head, such as the clearances between the clamp carrier **75** and the housing sections **13** and **14**.

Once the welding chamber has been purged, the electrode power supply is actuated to establish an arc. In a typical welding cycle, the motor power supply then provides a substantially constant direct current voltage to the motor to run the motor at a substantially constant speed and rotate the electrode carrier **101** at a substantially constant speed. With the electrode rotating at a substantially constant speed, and after an arc has been established, the electrode power supply begins to increase the electrode current until a desired steady state current has been obtained. The steady state motor speed and electrode current then continue for a predetermined time, such as the time required for one complete rotation of the electrode carrier **101**. Toward the end of the welding cycle, the speed of the motor is increased while the electrode current remains the same. Finally, the motor speed is increased still more while the electrode current is decreased to zero during a run-out portion of the cycle to produce an even weld. The welding cycle may extend over any desired time period, such as that required for two or three revolutions of the electrode carrier. Although a typical welding cycle has been described, various relationships between the electrode current and the electrode carrier speed and the rate of change of each may be used, depending upon the particular workpiece that is to be welded and the type of inert gas that is used. When the end of the welding cycle is reached and the electrode carrier **101** returns to its open position, the actuating pin **110** actuates limit switch **120** to stop the electrode carrier. The handle portion **11** may then be removed from the welding head **10** so that the handle portion **11**, the supply cable **12** and the control equipment may again be used to operate another welding head. The workpiece clamp is then opened, and the workpiece removed therefrom.

Although a specific embodiment of the invention has been shown and described in detail, various modifications and rearrangements may be made without departing from the scope of the invention defined by the following claims.

We claim:

1. An inert gas welder comprising a body portion, a welding chamber, an electrode, a carrier means for carrying said electrode along a path, and a clamping means for clamping a tubular workpiece to be welded adjacent said path; said clamping means including a first clamping portion having a first contoured clamping surface, first attachment means for securing said first clamping portion to said body portion, a second clamping portion having a second contoured clamping surface for cooperating with said first clamping surface to clamp said workpiece adjacent said path, and a second attachment means for securing said second clamping portion to said body portion and for moving said second clamping portion between an open position away from said first clamping portion and a closed position adjacent said first clamping portion; and said second attachment means including handle means movable along a handle path, and spring means interconnecting said handle means and said second clamping portion for permitting movement of said handle means along said handle path when said second clamping portion is in said closed position.

2. An inert gas welder as set forth in claim **1** wherein said spring means provides the sole means for transmitting force between said handle means and said second clamping portion.

3. An inert gas welder as set forth in claim **2** wherein said second attachment means includes overcenter locking means for locking said handle means in a predetermined position along said handle path.

4. An inert gas welder comprising a body portion, a welding chamber, an electrode, a carrier means for carrying said electrode along a path, and a clamping means for clamping a tubular workpiece to be welded adjacent said path; said clamping means including a first clamping portion having a first contoured clamping surface, first attachment means for securing said first clamping portion to said body portion, a second clamping portion having a second contoured clamping surface for cooperating with said first clamping surface to clamp said workpiece adjacent said path, and a second attachment means for securing said second clamping portion to said body portion and for moving said second clamping portion between an open position away from said first clamping portion and a closed position adjacent said first clamping portion; said second attachment means including handle means movable along a first path between a first position and a second position for moving said second clamping portion between said open position and said closed position, said handle means being further movable along a second path between said second position and a third position, link means for transmitting a force applied to said handle means to said second clamping portion and for multiplying said force applied to said handle means solely when said second clamping portion is in said closed position and said handle means is moved from said second position to said third position, and said link means including spring means for applying said increased force to said second clamping portion when said second clamping portion is in said closed position.

5. An inert gas welder as set forth in claim **4** wherein said body portion includes means for defining said first path of movement of said handle means, and said link means includes means for defining said second path of movement of said handle means.

6. An inert gas welder as set forth in claim **4** wherein said first path is a substantially straight line, and said second path is angularly related to said first path.

7. An inert gas welder as set forth in claim **6** wherein said angular relationship is substantially a right angle.

8. An inert gas welder as set forth in claim **4** wherein said link means includes a locking means for locking said handle means in said third position.

9. An inert gas welder as set forth in claim **4** including a pivotal member disposed on said body portion, said handle means including a hand receiving portion, socket means on said handle means for engaging said pivotal member when said handle means is in said second position and for permitting said handle means to rotate thereabout along said second path to said third position, a link member pivotally connected to said handle means at a pivotal axis, the distance between said pivotal axis and said pivotal member being less than the distance between said hand receiving portion and said pivotal member, said link member being pivotally connected to a means for transmitting force to said second clamping portion, and rotation of said handle means about said pivotal member to said third position displacing said first pivotal axis from one side of said pivotal member to another side of said pivotal member to lock said second clamping portion in said closed position.

10. An inert gas welder as set forth in claim **4** wherein said second contoured clamping surface includes a first surface means for engaging said workpiece on one side of said path and a second surface means for engaging said workpiece on the other side of said path; and said link means includes a first link operatively connecting said handle means and said first contoured means, a second link operatively connecting said handle means and said second surface means, and a locking means for locking said handle means in said third position.

11. An inert gas welder as set forth in claim **10** wherein said spring means includes a first spring acting between said first link and said first surface means, and a second spring acting between said second link and said second surface means.

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